

**REMARKS**

Claim rearrangement

The application, after entry of this amendment, now stands with claims 25-31, 33, 36-45, 47-70 and 72-94. Claims 30-31, 51 and 56-57 are withdrawn. Claims 74-94 are new.

Independent claim 25 has been amended to incorporate the features previously recited in claims 32 and 34, dependent claims 32 and 34-35 are cancelled and claims 33 and 36-38 are amended to correct dependency. Claims 26-31 and 39-48 are unchanged.

Independent claim 49 has been amended to clarify features in the claim. Dependent claims 50-70, 72 and 73 are not changed by the present amendment.

New independent claim 74 includes features from both claims 25 and 28. Dependent claims 75-83 include the features found in claims 26, 27, 29, 42-45, 47 and 48, respectively.

New independent claim 84 includes features from both claims 25 and 43. Dependent claims 85-90 include the features found in claims 26, 27, 44, 45, 47 and 48, respectively.

New independent claim 91 includes features from both claims 25 and 47. Dependent claims 92-94 include the features found in claims 48, 26 and 27, respectively.

Claim rejections – 35 U.S.C. § 112

In section 2 of the office action, claims 25-39, 32-34, 36-45, 47-50, 52-55, 58-70 and 73 stand rejected under 35 U.S.C. § 112, 1<sup>st</sup> paragraph, as having subject matter that is not enabled by the specification. In section 3, the same claims have been rejected as indefinite under 35 U.S.C. § 112, 1<sup>st</sup> paragraph, for lacking the written description adequately

describing the invention. In section 4, the same claims have been rejected as indefinite under 35 U.S.C. § 112, 2<sup>nd</sup> paragraph.

In each case, the Examiner objects to the claim language *"wall having a front face coated with fissile material arranged to expose the fissile material to a neutron flux for inducing fission and the release of fission fragments into the chamber "*. The Examiner points out that there would be neither an adequate description nor enabling disclosure as to how and in what manner having a front face coated with fissile material **alone** would insure release of fissile fragments into the chamber. The phrase is also considered indefinite by the Examiner.

In claims 25 and 49 as amended hereabove (and in the new independent claims 74, 84 and 91), the wording *"arranged to expose the fissile material to a neutron flux for inducing fission and the release of fission fragments into the chamber "* has been deleted, which is believed to overcome the examiner's objection. Instead, the *"whereby"* clause which was in the independent claims 25 and 49 as considered in the previous Office Action dated October 16, 2002 has been re-introduced. It is noted that this clause (*"whereby exposure of the fissile material to a neutron flux causes fission and the release of fission fragments into the chamber"*) was not objected to by the Examiner in a 35 U.S.C. § 112 rejection.

The feature addressed in the *"whereby"* clause is clearly a claim limitation. It means that when fission occurs due to exposure of the fissile material to a neutron flux, fission fragments are released into the chamber rather than being kept within the chamber wall. Structurally, it implies that the fissile material layer is not covered by any barrier that would retain the fission fragments within the thickness of the wall (e.g. as in the Bingham et al. patent in which fissile material is covered with protective coatings preventing the release of fission fragments into the gaseous medium).

The release of fission fragments into the chamber also results from the two-dimensional layout of the fissile material, as denoted by the claim wording *"front face coated with fissile material"*. The claim language does not imply that 100% of the fission fragments are kicked out of the wall into the interior of the chamber. Indeed, some of the fragments released will

migrate into the wall material or remain within the fuel layer. This explains why the claimed gas heating device includes means for cooling the rear face of the wall, thus achieving the hot gas/cool wall scheme on which the device relies (page 8, lines 30-31 or page 15, line 20 of the specification).

The claim wording is believed to exactly point out that feature of the invention.

\* \* \*

The Examiner further states that there would be neither an adequate description nor enabling disclosure as to what is the source of the "*neutron flux*" referred to in the claims. He reads the claim language as implying a neutron source that is separate from the fissile material because this material is recited as being exposed to a neutron flux.

The latter statement is respectfully traversed.

In any fission-based nuclear system, fission reactions take place because some fissile material is exposed to a neutron flux. The reason for the reaction is indeed the fission cross-section of the fissionable species in the presence of the neutron flux, the probability for the reaction to occur being proportional to the product of the cross-section and the neutron flux. This does not imply that the neutron flux to which the material is exposed comes from a neutron source that is separate from the fissile material. On the contrary, in all critical nuclear reactors, the neutrons which induce fission originate from a previous fissile reaction which took place within the fissile material itself. This is the famous "*chain reaction*" concept.

In the preferred embodiments of the invention disclosed in the specification, the layout of the fissile material is such that it forms a critical mass within the gas heating device, so that the "*neutron source*" is the fissile material itself. However, sub-critical arrangements, i.e. with a separate neutron supply, are not excluded (page 6, lines 26-28 of the specification).

\* \* \*

In section 3 of the detailed action, the Examiner notes that the initial claims 25 and 49 recite a device comprising *"a chamber containing gas"*, whereas other elements of the device have been introduced in the previous amendments, namely *"inlet means for introducing gas into the chamber"* and *"outlet means for evacuating gas circulated through said chamber"*.

In response, the inlet means and outlet means are clearly described in the specification:

- inlet means are adequately described in the specification, e.g. in the form of pores or small holes provided in the chamber walls (page 10, lines 16-19 ; page 22, lines 8-13 ; page 40, lines 8-14 ; page 48, line 7 – page 50, line 2);
- outlet means are described as, e.g., the open end of the tubes defining the chambers (see, e.g., page 44, line 24).

\* \* \*

For all of these reasons, Applicant submits that the §112 ¶¶ 1 and 2 rejections of claims 25 and 49, and their depending claims has been overcome, and respectfully requests the rejections be withdrawn.

Claim rejections - 35 U.S.C. § 102

Applicant acknowledges with appreciation that the rejections based on references which the Examiner had previously considered with respect to claims 25 and 49 (i.e. the Pettus, Arino et al. and Wiencek et al. patents) are not considered any more in the Office Action dated May 7, 2003.

Claims 25-27 and 32 now stand rejected as being anticipated under 35 U.S.C. § 102(b) by McArthur et al. (U.S. 3,952,263) or Eerkens (U.S. 3,391,281) patents. These two references have been of record since the first Examiner's Action on the merits mailed April 17, 2002.

In response, claim 25 now includes the features from claims 32 and 34, which are now cancelled. This amendment adds a neutron reflector with a certain thickness of carbon material that is not disclosed or suggested by either McArthur or Eerkens.

Thus, the rejection of claims 25-27 and 32 is now believed to be moot in view of the present amendment. Withdrawal of the §102 rejections is respectfully requested.

Claim rejections - 35 U.S.C. § 103

Claims 25, 26, 28, 29, 32, 33, 36-45, 47-50, 52, 54, 55, 58, 59, 61-64 and 67-70 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Culver (U.S. 5,873,239) in view of Bingham et al. (U.S. 4,759,911).

In response, Applicant traverses because the cited combination does not disclose or suggest a chamber wall with a front face coated with fissile material and fission fragments released into the chambers as claimed. Culver merely discloses a nuclear rocket engine including a nuclear reactor 12 and a heat exchanger or recuperator 14. The reactor 12 has fuel assemblies 48 and moderator rods 50. The fuel assemblies 48 are hollow to allow passage of the propellant gas, thus forming "chambers". Referring to figures 1, 2, 6 and 11 (see also column 9, lines 33-66), the propellant, which may be hydrogen, is circulated along the following path: feed line 214 (liquid form), heat exchanger 14 (where it is gasified), turbines 220-222, control drum manifold 28, strut channels 34, reflector channels 52 (around control drums 76), lower reactor plenum 57 (outside bellows members 60), lower reactor support plate holes 59, moderator rods 50, upper reactor support plate holes 59, upper reactor

plenum 55, strut channels 40, heat exchanger 14, neutron shield 106, bottom plenum 64, vessel holes 62, bellows members 60, fuel assemblies 48, exhaust plenum 16 and nozzle 6.

Culver fails to disclose (i) the wall of the chamber has a front face coated with fissile material, and (ii) fission fragments are released into the chamber to interact with the gas circulated through the chamber, as recited in each independent claim.

Culver's fuel assemblies 48 are of "conventional construction" (column 4, line 61). This is understood to refer to an assembly wherein fissile material is housed within a suitable cladding (e.g. Zircalloy, steel, etc.), in particular for the purpose of preventing dispersion of the fuel and radioactive waste.

The Examiner appears to agree that Culver fails to disclose the front face of a chamber wall coated with fissile material and that fission fragments are released from the wall, but considers that the Bingham et al. patent would have suggested these features.

However, as Applicant already indicated in the response to the previous Office Action, Bingham et al. teaches away from the claimed fuel arrangement. First, the chambers defined within Bingham et al.'s fuel elements do not have their front face coated with fissile material as claimed. Those front faces are coated with zirconium carbide to block fission products.

Bingham et al. disclose a gas-cooled nuclear fuel element comprised of a plurality of coaxial nested rigid porous cylinders of progressively decreasing circumference to allow positioning of each of the cylinders within the cylinder of the next largest size (column 2, lines 32-39). Each cylinder is made of a reticulated vitreous carbon skeleton of appropriate pore and ligament size, coated with a carbide fuel obtained by annealing uranium, plutonium or americium deposited by vapor deposition coating. After such coating, a protective carbon layer is deposited by chemical vapor deposition, and a final protective layer of zirconium carbide is deposited by chemical vapor deposition (column 3, lines 10-19).

Bingham et al.'s design optimizes the fuel distribution across the thickness of the elements in order to operate each cylinder at its maximum power level within the heat transfer constraints existing at its radial location. This is accomplished by having two protective coatings made of carbon and zirconium carbide for the clear purpose of preventing the release of fission fragments in the gaseous cooling medium. Bingham et al. merely propose to heat up the cylinders in which the fission fragments remain confined, and to transfer the heat to the flowing gas.

For this reason alone, Applicant submits that the §103 rejection of independent claims 25 and 49, and their depending claims has been overcome. Therefore, withdrawal of the §103 rejection is respectfully requested.

Second, considering the combination of the Culver and Bingham et al. references, those skilled in the art would not have been instigated to provide a fuel arrangement such that fission fragments evolved by the fission reaction are kicked from the chamber walls into the chamber volume containing flowing gas to more efficiently heat up the latter. In each of the two references, the kinetic energy of the fission fragments is transformed into heat within the fuel, and the heat thus evolved is then transferred to the gas located within the chamber. The physical principles involved are different from the present invention (in which the gas is directly heated from the kinetic energy of the fission fragments). Those differences directly result from the claimed features (i) and (ii), as distinguished hereabove over the Culver reference.

In view of the different structures and operations, it would not have been obvious for those skilled in the art to derive the subject matter of the independent claims of the present application from any combination of the Culver and Bingham et al. references.

For this additional reason, Applicant, submits that the §103 rejection of independent claims 25 and 49, and their depending claims has been overcome. Therefore, withdrawal of the §103 rejection is respectfully requested.

\* \* \*

In section 7 of the Office Action, dependent claims 27, 34, 53 and 60 stand rejected under 35 U.S.C. §103(a) as being unpatentable over the Culver-Bingham et al. combination and further in view of the Chikin et al. paper and an excerpt of the Nuclear Engineering Handbook (Etherington). In section 8 of the Office Action, claims 65, 66, 72 and 73 stand rejected under 35 U.S.C. §103(a) as being knowledge “well-known in the art.”

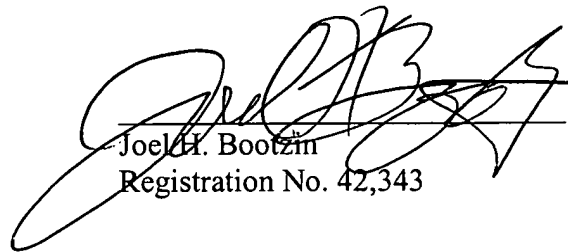
All of these claims depend on either independent claim 25 or 49 which is allowable for the reasons set forth hereabove. The two additional references and knowledge in the art referred to here by the Examiner do not add to the missing feature of the front face of chamber wall with a fissile coating and release of fission fragments from the wall. For these reasons, Applicant submits that the cited combinations do not disclose or suggest all of the features of claims 27, 34, 53, 60, 65, 66, 72 and 73, and respectfully request that the §103 rejection of these claims be withdrawn.

For the foregoing reasons, Applicant respectfully requests consideration and allowance of all pending claims. The Examiner is invited to contact the undersigned attorney if an interview would expedite prosecution.



No fee is thought to be due in conjunction with the submission of this Amendment. However, the Director is hereby authorized to charge any deficiency to Deposit Account No. 18-2284 of Piper Rudnick, duplicate copy attached.

Respectfully submitted,



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